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Tax Shares in Developing Economies: A Panel Study

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Abstract

The share of income collected in taxes is much higher in developed economies than in developing economies, yet among developing economies, the influence of per capita income on the tax share is much less clear. Most studies to date have discovered no statistical relationship between the tax share and per capita income when other measures of economic development are included in the model. The present study finds a statistically significant negative relationship between the tax share and per capita real GDP for a sample of eight African countries over a nine year period of their development. This study also finds that the tax share is negatively related to the agriculture share but positively related to the trade and mining shares. The model is used to compute tax effort indices for the eight countries. A statistical test is performed to identify those countries with tax effort indices greater than one and those with tax effort indices less than one.

TAX SHARES IN DEVELOPING ECONOMIES: A PANEL STUDY

Typically, tax shares in developing economies are studied using cross-country data on a sample of low income countries.[1] The goal is to measure a country's tax effort by comparing its predicted tax share with its actual tax share where its predicted tax share is determined from a regression relating tax shares to various explanatory (control) variables such as per capita income, the ratio of imports and exports to GDP, and the share of agriculture and mining in GDP. If the ratio of the actual share to the predicted share is less than one, the country is identified as a low tax effort country. Conversely if the ratio is greater than one.

This approach has been subjected to many criticisms. Richard Bird (1976) bemoans the lack of theoretical justification underlying the models purported to explain taxable capacity. How, for example, are differences in demand for public services accounted for? Bird also points to the poor quality of data and to the inadequacy of cross-country data for drawing inferences about changes that occur over time. He further cautions against using as a standard an average that is based on "some abstract hybrid of all countries".[2] It is important to take into account the economic, political, and administrative conditions of the country (or homogeneous collection of countries) being studied.

Despite these criticisms, tax effort indices are widely used for policy purposes. They may, for example, be used for judging the potential of taxation for funding public spending increases. High

indices indicate that taxation as a funding source is already highly burdened and other funding sources should be tapped or spending increases postponed. Tax effort indices are also used by international agencies as a basis for international grants. It is sometimes argued that distribution of grants on a straight per capita basis would allow countries to substitute external funds for locally raised funds. Targeting funds to high tax effort countries provides some assurance that local revenue sources have already been tapped.

Since tax effort indices are important guides to policy in developing economies, it is crucial that they be estimated using appropriate techniques. This study attempts to account for some of the criticisms raised of earlier studies by first of all offering a stronger theoretical basis for the tax share model. An optimal tax share is derived assuming welfare maximizing behavior on the part of public decision makers subject to the availability of tax bases. Secondly, rather than using cross-country data, this study uses a panel of cross-country and time series data for a relatively homogeneous group of eight African countries (Ivory Coast, Senegal, Mali, Cameroon, Kenya, Nigeria, Ghana, and Tanzania). The first four of these countries are Francophone and the remaining four Anglophone. The time period of study is 1973 through 1981.

In Section I, a theoretical model of tax behavior is developed, and the data and econometric methods used to analyze the data are described. In Section II, the results are presented, and in Section III, their policy and behavioral implications are discussed.

I. The Model and Data

In order to model tax behavior of a developing country, I assume that fiscal choices reflect the actions of a public decision maker or council of public decision makers. I further assume that they maximize a welfare function that has as its arguments private disposable income and public goods and services. Welfare is maximized subject to a budget constraint that accounts for the alternative modes of domestic financing.

The welfare function of the decision maker is

$$(1) \qquad U = U(Y - T, G_C, G_I)$$

where $Y - T$ is disposable income in the private sector (equal to gross domestic product, Y, less tax revenue, T), G_C is government consumption, and G_I is government investment expenditure for development purposes. All variables are in real per capita terms.

In maximizing the welfare function, the decision maker is constrained to balance the budget. The sum of revenue inflows must equal the sum of public expenditures:

$$(2) \qquad T + F + B = G_C + G_I$$

where F is the sum of foreign grants and loans and B is domestic borrowing.

The decision maker is also constrained by institutional constraints that limit tax choices such as the availability of convenient tax handles (tax bases that lend themselves to taxation). In developing countries, the administrative difficulty of collection as well

as political resistance to taxation pose serious obstacles to achieving a desired level of tax effort. It is assumed that the actual tax share, T/Y, is a function of the desired tax share, (T/Y)* and of the availability of certain tax bases. Specifically,

$$(3) \qquad T/Y = f[(T/Y)^*, A_Y, (X + M)/Y, N_Y)$$

where A_Y is the share of agriculture in income, X is exports, M is imports, and N_Y is the share of mining in income. It is expected that the actual tax share is positively related to the desired tax share and negatively related to the share of agriculture in income since agriculture is a difficult sector to tax. This is especially so in African countries where land is often communally owned and much agriculture occurs in the non-market sector. It is further expected that the actual tax share is positively related to the share of trade in income and the share of mining in income. These sectors provide convenient handles for taxation since the goods must pass through ports of entry and exit, they are highly monetized, and they are dominated by a few large organizations.

The desired tax share is determined by maximizing the welfare function subject to the balanced budget constraint. It is assumed that the welfare function takes the form:

$$(4) \qquad U = a \ln(Y-T-Y_S) + (1-a) \ln(G-G_S)$$

where a is a constant between zero and one, G is the sum of government consumption and government investment, Y_S is subsistence income, and G_S is subsistence public goods and services. Maximizing U with respect

to T and G subject to constraint (2) yields the following equation for the desired tax share:

$$(5) \qquad (T/Y)^* = (1-a) - a[(F+B)/Y] + [(aG_S-(1-a)Y_S)/Y]$$

which says that the desired tax share is positively related to the welfare weight on government goods and services, (1-a), and negatively related to the ratio of foreign gifts, grants and domestic borrowing to income. The relationship between the desired tax share and the level of income is ambiguous depending for its sign on the sign of $(aG_S - (1-a)Y_S)$ which in turn depends on subsistence levels of government goods and services, on income, and on the welfare weight. It is impossible to predict a priori whether this difference will be positive or negative.

Substituting equation (5) into equation (3) and assuming (3) to be a linear function yields the basic model of this study:

$$(6) \qquad (T/Y) = b_0 + b_1[(F+B)/Y] + b_2(1/Y) + b_3A_Y + b_4[(X+M)/Y] + b_5N_Y + e$$

where b_1 and b_3 are expected to be negative, b_4 and b_5 are expected to be positive, and b_2 is of indeterminate sign. The properties of the error term, e, are described later.

The sample data are represented by eight cross-country units over nine periods of time. Hence, there are 72 = 8 x 9 observations. The data are from the African Statistical Yearbook published by the United Nations and from the International Financial Statistics published by the International Monetary Fund.

The model is first estimated using ordinary least squares regression on the pooled data. Next, it is recognized that omitted variables may lead to changing cross-section and time-series intercepts. A covariance model is estimated which allows for changing intercepts by the addition of dummy variables. Finally, the possibility is introduced that the model is first-order autoregressive with contemporaneous correlation between cross sections. Specifically, the autoregressive model assumes the errors are random:

$$(7) \qquad e_{ij} \qquad i=1,\ldots,8; \quad j=1,\ldots,9$$

and have the structure:

$$E(e_{ij}^2) = s_{ii} \qquad \text{(heteroscdasticity)}$$

$$E(e_{ij}e_{kj}) = s_{ik} \qquad \text{(contemporaneously correlated)}$$

$$e_{ij} = r_i e_{ij-1} + u_{ij} \qquad \text{(autoregression)}$$

Heteroskedasticity may arise if there is a higher variance in the estimated residuals for the larger countries in terms of population or income. Contemporaneous correlation arises since the countries are all from the same geographic region, and autoregression arises if the error this period in country i depends on the error last period in country i. The model is estimated using generalized least squares on the transformed data.[3]

In the estimation, all data have been deflated to constant 1980 prices using each country's own GDP deflator. The variables have also

been converted to dollars using the current year exchange rate and put on a per capita basis.

II. Econometric Results

The estimation of equation (6) yields estimates of the coefficients and their properties. Table 1 shows the regression, covariance, and autoregressive results.

A. Description of the results

As seen in Table 1, the regression model which assumes a constant structure over time and across countries performed poorly. Only one coefficient was of expected sign and significantly different from zero, the coefficient of trade share, $(X + M)/Y$. The coefficient of the share of grants and borrowing in GDP, $(F + B)/Y$, is positive and significantly different from zero, an unexpected result. The other coefficients are of expected sign but not significantly different from zero. Further, the R^2 and adjusted R^2 are relatively low and the Durbin Watson statistic, DW, indicates rejection of the null hypothesis of no autoregression at the 1% confidence level.

The covariance model (column 2 of Table 1) fits the data much better than does the regression model. As mentioned above, the covariance model allows the intercept term to vary over time and over country. This was accomplished by introducing eight time dummy variables and seven country dummy variables.[4] The coefficients of the dummy variables are not shown in the table because they are of little interest in themselves. Of primary interest are the coefficient estimates for the explanatory variables. Note that these are all of

Table 1

Model Estimation Results Using Pooled Data, 1973-81

Variable	Regression Model	Covariance Model	Autoregressive Model
Constant	.103**	.164**	.169**
(F+B)/Y	.252**	-.016	-.125**
1/Y	-.569	11.998	14.602**
A_Y	-.090	-.208*	-.142**
(X+M)/Y	.113**	.114*	.057*
N_Y	.005	.170	.125
SSE	.053	.026	.023
R^2	.421	.713	
$\bar{R}^2$	.377	.601	
DW	.923	1.041	

*Significant at 5% level.
**Significant at 1% level.

expected sign, though not always significantly different from zero. The R^2 and adjusted R^2 are significantly higher than in the regression model, however the Durbin Watson statistic continues to indicate rejection of the no autoregression hypothesis.

One drawback of the covariance model relative to the regression model is that the covariance model sacrifices degrees of freedom. By comparing the residual sum of squares for the two models, one can test whether the ordinary least squares assumptions are proper. The appropriate test statistic is:

$$(8) \qquad \frac{(ESS_1 - ESS_2)/(N+T-2)}{(ESS_2)/(NT-N-T)} \sim F_{N+T-2,NT-N-T}$$

where ESS_1 and ESS_2 are the residual sum of squares using the regression and covariance model, respectively. In our case, the F statistic is 3.808 which exceeds the critical F at the 1% confidence level leading to rejection of the regression model in favor of the covariance model.

Even though it is less restrictive than the regression model, the covariance model itself is still highly restrictive. It assumes that the regression disturbances are independent across countries as well as homoskedastic and not autoregressive. Since all the countries in this study are from the same region, raise similar crops, engage each other in trade, and, in some cases, use a common currency, these assumptions are most likely not appropriate. The autoregressive model, whose results are shown in column 3 of Table 1, addresses this concern.

In the case of the autoregressive model, all the coefficients are of expected sign and all, save one, are statistically different from zero at the 5% level or better. The only insignificant coefficient is that of the mining share, N_y, but it is of expected sign. The insignificance of this coefficient is not surprising, however, since mining is an unimportant industry in these countries. The autoregressive model also fits the data better than the other two models as seen by its SSE of .023 as compared to SSE's of .053 and .026 for the regression and covariance models, respectively.

Of the three estimation methods, regression, covariance, and autoregression, the latter not only fits the data better but also better confirms our theoretical expectations. Next, the estimation results are applied to the computation of tax effort indices for the eight countries studied.

B. Computation of the tax effort index

The tax effort index is computed by taking the ratio of the actual tax share to the predicted tax share. As mentioned earlier, if this ratio is greater than one, the country is said to be a high effort country. Conversely if the ratio is less than one.

The denominator of the tax effort index is the predicted tax share. Since one purpose of computing the tax effort index is to make cross-country comparisons, two of the models developed earlier, the covariance and autoregressive models, are inappropriate for predicting tax share since they control for cross-country differences through the use of country dummy variables. Hence, these models are reestimated

without the country dummies, and the reestimated models are used to predict tax share. The ratio of predicted to actual tax share is then computed for each country for each year.

In order to see how these indices compare across countries, a regression is run relating the tax effort index to the country dummy variables. The model has the form:

$$(9) \qquad \text{Actual tax share/predicted tax share} = c_0 + \sum_{i=1}^{7} c_{1i} D_i$$

where:

$D_i = 1$ for country i and

$D_i = 0$ otherwise.

Since inclusion of dummy variables for all eight countries could cause perfect multicollinearity, a dummy variable for one country was omitted to be captured in the constant term. The results from estimating this model for each of the three tax share models (regression, covariance, and autoregressive) appear in Table 2. The constant term can be interpreted as the tax effort of the omitted country, Tanzania. The slope coefficients for each country reflect the differential tax effort between that country and Tanzania.

Note that the regression based on the autoregressive model fits the data best using the adjusted R^2 criterion. For that regression, all slope coefficients are negative and significantly different from zero. Note also that the autoregressive model accentuates the inter-country differences in tax effort.

Table 2

Ordinary Least Squares Estimation of
Tax Effort by Country, 1973-81

Variable	Regression Model	Covariance Model	Autoregressive Model
Constant	1.151**	1.164**	1.341**
Cameroon	-.223**	-.194**	-.530**
Mali	-.275**	-.293**	-.499**
Kenya	-.057	-.076	-.201**
Ivory Coast	-.231**	-.251**	-.381**
Ghana	-.207**	-.224**	-.358**
Senegal	-.034	-.078	-.317**
Nigeria	-.189*	-.202**	-.327**
R^2	.275	.277	.539
$\bar{R}^2$	.196	.198	.489

*Significant at 5% level.
**Significant at 1% level.

Tax effort indices are calculated for each country based on the three models of Table 2. These results are shown in Table 3. A t-test was performed to see which of these indices are significantly different from one. For the regression model, only Tanzania's tax effort was significantly greater than one at the .05 level. For the covariance model, tax effort in Mali tests significantly less than one, and in the autoregressive model, tax effort in the Cameroon tests significantly less than one as well. In both the covariance and autoregressive models, tax effort in Kenya is significantly greater than one. For the other countries, there is no evidence that their tax effort is significantly different from one.

C. Comparison of results with those of other studies

Among the first modern cross-country studies of tax ratios were by Lotz and Morss (1969, 1970). They developed a model which has become a standard for future studies:

$$(10) \qquad (T/Y) = c_0 + c_1 Y + c_2 [(X+M)/Y] + e$$

which they estimated on a sample of 72 countries and separately for high and low income countries. They found a significant positive relationship between the tax share and both per capita income and the degree of openness (measured by the sum of exports and imports divided by GNP) for the entire sample and for the low income subsample but not for the high income sample. However, their model failed to explain a high proportion of the variance in the tax ratio for either of the subsamples (adjusted R^2 of .000 for the high income countries and .200

Table 3

Tax Effort Index by Country

Country	Regression Model	Covariance Model	Autoregressive Model
Tanzania	1.151[a]	1.164[a]	1.341[a]
Cameroon	.927	.970	.811[b]
Mali	.876[b]	.871[b]	.842[b]
Kenya	1.094	1.088[a]	1.140[a]
Ivory Coast	.919	.913	.960
Ghana	.944	.940	.983
Senegal	1.117[a]	1.086	1.024
Nigeria	.962	.962	1.014

[a]Significantly greater than 1 at 5% level.

[b]Significantly less than 1 at 5% level.

for the low income countries). In later work, they were able to increase the proportion of the variance explained by the model to .453 for low income countries by adding monetization, decentralization, and export concentration variables to the model but with the result that per capita income was no longer significant.

Shin (1969) attempted to extend the Lotz-Morss study by adding independent variables to the model: the ratio of agriculture to total income, the rate of growth of population, and the rate of growth of prices. For low income countries, he found only the rate of price increase and the rate of population growth to be significant. Shin offered little a priori justification for these variables.

Bahl (1971) tried still a different model for explaining tax shares in developing economies. In his model, the agriculture share of income replaced per capita income as a proxy for the stage of development, the mining share of income was introduced to reflect the sectoral composition of income produced, and openness was measured by the export share of income. The latter was found to be insignificant and subsequently dropped from the model. He found taxable capacity to respond negatively to higher agriculture shares and positively to higher mining shares. More recent IMF studies by Chelliah, Baas, and Kelly (1975), Tait, Gratz, and Eichengreen (1979), and Tanzi (1987) estimated the Lotz-Morss and Bahl models using newer cross-country data. Per capita income continues to be a nonsignificant explanatory variable while the agriculture share and mining share have significant coefficients of expected sign but not when they are used in conjunction with per capita income.

The estimation equation in the present study differs somewhat from those of earlier studies. Per capita income enters the model in inverse form so that its coefficient, if positive, indicates a negative relationship between the tax share and per capita income. The autoregressive model estimates this coefficient to be positive and significant though the other two models do not find a significant coefficient. A negative relationship between the tax share and per capita income is consistent with the theoretical model proposed in this study but inconsistent with the results of earlier studies which generally show no relationship between tax share and per capita income.

Another difference between the present study and earlier studies is the inclusion in the present study of the share of foreign grants, loans, and domestic borrowing in income. The theoretical model hypothesized a negative relationship between this variable and the tax share. This was confirmed by the autoregressive model of the present study.

Finally, the present study extends the literature by using panel data rather than cross-country data to estimate the tax share equation. An advantage of panel data is that it adds degrees of freedom, allowing the estimation of the tax share equation on a fairly small and homogeneous group of countries. However, a panel of data poses estimation problems not encountered in a simple cross-country study. In particular, assumptions must be made about the error structure that are not of concern in a cross-country study. The autoregressive model

used in this study performed in a very satisfactory way, confirming the expectations of the theoretical model and fitting the data well.

III. Conclusions

The results obtained from the estimation shed light on the statistical relationship between tax share and a set of explanatory variables including per capita income, nontax income share, agriculture share, openness, and mining share in a set of African countries. The signs of the estimated coefficients are consistent with the expectations of a simple theoretical model of the public sector decision process. The major conclusions of the study are:

(1) There is a negative and significant relationship between per capita income and the tax share when other measures of economic development are included in the model. Since per capita income enters the model in inverse form, its positive and significant coefficient suggests that an increase in per capita income will result in a decrease in the tax share after controlling for other variables. This result, though consistent with the expectations of the theoretical model, is consistent with the results of earlier studies which estimate the relationship to be either insignificant or positive.

(2) Increases in foreign grants and loans and in domestic borrowing lead to decreases in the tax share. This negative relationship is picking up a displacement effect that is consistent with the expectations of the theoretical model.

(3) A large trade sector is associated with a high tax share while a large agriculture sector is associated with a low tax share. This is consistent with the results of earlier studies which include these variables to reflect the availability of tax handles. This study found no significant relationship between the tax share and the mining share, perhaps because mining is not an important industry in the countries studied.

This study goes on to apply these results to the calculation of tax effort indices for the eight African countries in the sample. It is found that two countries have tax effort indices statistically greater than one, two have tax effort indices statistically less than one, and the remaining four countries have tax effort indices statistically equal to one. Care must be taken in the interpretation placed on the tax effort index. It is dangerous to use such an index to separate the "bad guys" from the "good guys" because it is unclear whether or not all relevant influences on tax effort have been included. The index may be useful, however, as a descriptive statistic which can serve as a helpful policy guide. One might conclude, for example, that a country with a high tax effort index has little potential for financing additional government spending through taxation as opposed to countries with low tax effort indices. Whether one agrees with their use or not, tax effort indices are used by national and international agencies to justify foreign aid. Hence, as an objective measure of tax performance, they deserve careful measurement.

Future study should be directed toward expansion of the data base to include more countries and a longer time horizon. Data inconsistencies in the pre-1973 data prevented the present study from using a longer horizon. Another extension would be to use an alternative form of the welfare function as the base for the theoretical model. The Cobb-Douglas form was chosen for the present study because it leads conveniently to a linear estimation function. Expansion of the model to include additional explanatory variables or to disaggregate the present variables could add richness to the model. As better and more consistent data become available for developing economies, expanded models can be employed. Finally, it has been argued that for some purposes tax effort should be measured in terms of discretionary changes in tax receipts rather than automatic changes.[5] To do this requires more data than were available for this study.

FOOTNOTES

[1]As examples, see Chelliah, Baas, and Kelly (1975) and Tait, Gratz, and Eichengreen (1976).

[2]Bird (1976), p. 258.

[3]The data are transformed in a first stage in which the autoregressive characteristic of the data is removed (asymptotically) using a consistent estimate of the first-order autoregressive parameter. This model is described in detail in Kmenta (1986), pp. 622-625.

[4]One time and one country dummy variable were omitted since their addition would result in perfect collinearity among the explanatory variables.

[5]See Bird (1976), pp. 260-261 and Newlyn (1985).

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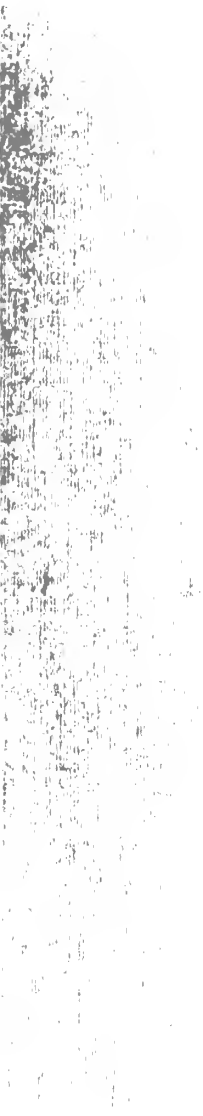

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